Author: Patrizia Ravizza

Lesson plan Title: Gravity on Earth and in the Solar System

School	**Middle**
Year / Class	**3**
Subject: Earth Science	**Topic: Gravity on Earth and in the Solar System**
CLIL language	**English**

Teacher / Teaching team profile	Teacher's role: **Main Teacher**	**Subject taught: Mathematics and Science**

Student group profile (general)	CEFR Level: **A1** **A2**	
	○ Little experience of CLIL (pupils had a 10 hour module about the Human Nervous System in October 2015) ○ Mother tongue (Italian): 16	○ Migrant background: 2 ○ Special Educational Needs: 0

Timetable fit	Lesson	Previous lessons: The Earth (shape, size and mass)
		Future lessons: The Earth (rotation and revolution)

Resources & tools	Bentley Kay '*The TKT Teaching Knowledge Test Course CLIL Module Content and Language Integrated Learning*' (2015) Cambridge: Cambridge University Press Bertini, Danise, Franchini '*Scienza under 14 Protagonisti delle scienze*' (2011) Varese: Mursia Scuola – Mondadori Education S.P.A. Coyle Do 'CLIL Planning Tools for Teacher. 4Cs Curriculum Guidance. 3As Lesson Planning Tool. Matrix Audit Tool for Tasks & Materials' (2005) Nottingham: The University of Nottingham **http://cmap.ihmc.us/cmaptools** **http://www.ck12.org/book/CK-12-Earth-Science-For-Middle-School** **https://en.wikipedia.org/wiki/Surface_gravity** **http://spaceplace.nasa.gov/menu/solar-system** **http://settlement.arc.nasa.gov/teacher/lessons/bryan/microgravity/gravback.html** **https://www.esa.int/esaKIDSen/index.html** **https://www.youtube.com/watch?v=Ye8AxqndVYY**

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<table>
<tr><td rowspan="2">Students' prior knowledge, skills, competencies</td><td>Subject</td><td>Language</td></tr>
<tr><td>Some of the students gained basic knowledge of the Solar System at Primary School.
Student are able to:
- compute with proportions
- use pocket calculators
- read the pieces of information written in a table
- work out a True/False statements exercise.
Students usually work in pairs during the mathematics exercises.</td><td>These students started learning English during the third year of Primary School. Some of them are going to take the KET certification in May 2016.
According to the school curriculum, the students are able to use:
- simple past forms of regular and irregular verbs
- past continuous and present perfect
- future forms (will, present continuous, be going to)
- personal pronouns used as subject or object (direct or indirect)
- time and place prepositions
- adjectival comparative and superlative forms
- modal verbs (can, could, must, should, would)
The students are also able to:
- describe simple events of the past
- name the parts of the day, the months and the seasons of the year
- illustrate future plans and intentions
- describe the spatial position of objects
- compare objects
- define rules and prohibitions</td></tr>
<tr><td>Learning Outcomes expected for this lesson</td><td colspan="2">Cognitive-linguistic competencies to develop. E.g. see the document "Critical thinking skills".
Content
Students:
- know the shape of the orbit of the Earth and of the Moon around the Sun
- know how gravity affects Earth, the Moon and other planets in the solar system
- are aware of the relevance of gravitational pull for life on Earth
- are aware that gravitational pull depends on the mass and on the distance of the bodies considered
- are aware that the weight of a body changes from one planet to another
Communication
Pupils:
- are able to describe the orbit of the Earth and of the Moon around the Sun
- are able to use key vocabulary and phrases related to forces: mass, strength, gravity, directly dependent on, inversely dependent on, gravitational pull, elliptic path, gravitational acceleration
- are able to use the present simple to describe, define and explain the movements of the Moon and the Earth around the Sun
- are able to use comparative forms of the adjectives: bigger than, smaller than, stronger than, weaker than
- are able to use superlative forms of the adjectives: the biggest, the most important
- are able to understand the meaning of specific vocabulary by the contest
Cognition
The students:</td></tr>
</table>

	- are able to compute different weights of bodies on different planets - are able to fill in the entries on a table - are able to summarize new knowledge - are able to use visual organizers to display the most important pieces of information contained in a text **Culture** The students - are aware of different gravitational pulls on different celestial bodies

Methodology	*How the teacher in a particular lesson manages to integrate language and content* **Interactions** The pupils are going to experience individual, pair, group and whole class group work, depending on the different activities planned. **Scaffolding** Activity n°1 The pupils are given some sentence starters to help them to compare their answers. These are written on the blackboard behind the shoulder of the teacher or on the IWB, with the help of more able pupils. ***I agree with you on the first, second,… sentence.*** ***No, I don't agree with you on the first, second,… sentence.*** ***I think that the first, second,.. sentence is false/true*** Activity n°2 The teacher leads the discussion among the pupils, uses examples, pictures or visual aids to explain why an answer is wrong. Activity n°3 The video clip is repeated twice. Some extra time is given if needed to answer the questions on the worksheet. Activity n°4 There are some more sentence starters for the activity, written on the IWB. ***I think that the first/second/third sphere is the Moon, Earth, Sun,……*** ***The Moon/Earth/Sun is made of ……(rock, fire, gas, ashes, air, water,…)*** Activity n°5 The teacher draws examples (as given in the next page or similar) on the blackboard (or IWB) to explain the text and makes the pupils copy them on their exercise book.

	The teacher uses body language and mimes the meaning of some sentences. Activity n°6 The teacher gives first the instructions to fill in the entries of the table and then demonstrates how to calculate the entry of a cell in the table. Pupils copy the example in their exercise book. With the task on-going, the teacher walks around the classroom and helps students asking for support. If necessary the teacher suspends the task, gives some piece of advice to the whole class and then lets the pupils go on with it. Activity n°7 The gravitational force's formula is written on the IWB. When an answer in the table is wrong, the teacher asks one of the more able pupils, or a volunteer, to explain on the IWB the procedure for the computation of the right answer. Activity n°8 The teacher uses reformulation, simplification and exemplification presenting the homework to the pupils. **Differentiation for less able student** The text used in activity n°5 and the table used in activity n°6 are simplified or shortened (**Appendix 7 and Appendix 8**) **Differentiation for more able students** When more able students finish their task they prepare a word search for the class using a grid, (**Appendix 9**) made by the teacher, and the words of the mind map of the first lesson. This word search is going to be used for a group game during the next lesson. **Tools for assessment** In this lesson there are different kinds of formative assessment, performed by the teacher and by the pupils (peer assessment). They are all specified near every activity in the following table.

Activity	Activity aims	Activity Procedure	Language	Interaction	Materials (please cite all sources)	Timing	Assessment
1	*What is the purpose of this activity of the lesson.* To warm the class up To check the homework To remember the facts learned in the previous lesson	*What will happen during this stage of the lesson* Pupils in pairs compare their homework (True/False statements, in **Appendix 1**) in order to check the choices made.	*Competencies developed* Pupils compare their answers with each other. Pupils give feedback to their peers	Pair work	*What materials are used during the lesson? Flashcards, pictures, songs, PowerPoint, ICT tools, etc. All materials should be referenced clearly paying attention to the copyright rules* Worksheet made by the teacher and used for the homework	*The timing of each activity should be as accurate as possible.* 5 minutes	*Assessment tools in relation to the learning outcomes of the lesson* Peer assessment
2	To clear up every doubt on the previous knowledge To reinforce understanding of the facts To expand the pupils' talking time	In turn a pupil, volunteer or chosen by the teacher, reads aloud a statement on the IWB and writes his own answer. In case of mistakes, the class tries to find out what went wrong during the task with the guidance of the teacher.	Pupils try to explain their reason for the answer given	Whole class	IWB with the text of the given homework (made by the teacher)	5 minutes	The teacher observes the statements made by the pupils. The teacher asks some questions to help pupils to understand the reasons for the mistakes made.

3	To know the movements of the Earth, the Moon and the Sun respectively	The pupils read silently the worksheet given to them by the teacher (**Appendix 3**) and ask for explanations if needed. Pupils watch a video clip (2:44 minutes) on the Interactive White Board IWB (the Internet link is in **Appendix 2**). The video shows an animation with no spoken comments, on the movements of Earth, Moon and Sun. At the end, each of the students answers the six questions on the worksheet.	Pupils name the three spheres seen in the video clip.	Individual work	A worksheet (made by the teacher) with six questions. IWB with an Internet connection.	5 minutes	The teacher observes the pupils during the video clip viewing and while they perform the task given.
4	To guess the composition of some of the celestial bodies	The teacher asks the class about their answers and records on a poster the guesses of the student about the last three questions (what is the Sun/ Earth/ Moon made of?).	Pupils hypothesize the composition of stars, planets and satellites.	Whole class	A poster of white paper and some felt tip pens to write on it or the IWB.	5 minutes	The teacher takes note of the mistakes and of the guesses. The mistakes are investigated with the whole class, in order to achieve the right answer.

5	To be aware of the gravity field of the Earth To know the relevance of gravity and its consequences	The teacher gives the students a worksheet (**Appendix 4 or Appendix 7 for less able students**) with a text about gravity and reads it aloud checking the students' comprehension with simple questions.	Pupils ask the teacher to repeat new words or for the meaning of unknown words. Pupils express their understanding of the content.	Whole class	Worksheet with a text on gravity, prepared by the teacher. IWB.	15 minutes	The teacher checks comprehension of the text asking simple questions.
6	To compare different values of the gravity on different planets of the solar system	Pupils in pairs with the help of a pocket calculator fill in a table(**Appendix 5 or Appendix 8 for less able students**), computing the weight of a boy and of his cat on the surface of different solar bodies**.**	Pupils ask for explanations about the formula of gravity. Pupils compare their results and discuss them when these are different.	Pair work	Table, prepared by the teacher, with the gravitational accelerations on the surfaces of different solar bodies (Moon, Earth, Sun, Mercury...), IWB.	10 minutes	The teacher observes the pupils performing the task and takes notes of difficulties arising. With the help of a simple rubric (**Appendix 10**) the teacher observes the ability to compute and to compare the results shown by the pupils.

7	To check the answer in order to consolidate the procedure to compute the weight of a body knowing its weight on the Earth and the gravitational acceleration of another planet.	In turn, pupils are called to the IWB to fill in the table with their answers. If needed the computations are made together to explain the mistakes found.	Pupils tell their solutions, explain their choices about the values for the gravitational pull.	Whole class	IWB with the void table assigned to the pupils	5 minutes	The teacher takes notes of the mistakes made by the pupils in the computational procedure, finding out if these are depending on proportions (and then there is some review to do in maths) or on other reasons.
8	To summarise the facts learned in this lesson	The teacher assigns the homework. The homework (a conceptual map) is shown on the IWB and a copy of it (**Appendix 6**) is given to each pupil. Pupils scan the map and ask for explanation. They have to complete it at home, to summarize the pieces of information given during the lesson.	Pupils ask for explanation about the homework.	First whole class, during the explanation of the homework, then individual work at home.	Worksheet, made by the teacher, with an incomplete conceptual map and some words to choose from in order to perform the task. IWB.	5 minutes	The teacher assesses the understanding of the homework, writing some wrong words in the conceptual map on the IWB and asking the pupils if they agree with the performed gap filling. At the beginning of the next lesson the pupils are going to compare their homework (peer assessment).

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Appendix 1

True or False?

The Earth is flat _____

Most of Earth's surface is covered with water _____

Before space exploration people didn't know the Earth was round _____

When a ship sails over the horizon the top part disappears first _____

Earth is the fourth planet from the Sun _____

The outer planets are made of rock _____

The inner planets are made of rock _____

Water and nitrogen are crucial to life on Earth _____

Appendix 2

link to the video watched during Activity n°3
https://www.youtube.com/watch?v=Ye8AxqndVYY

Appendix 3

Questions to be answered:

1) What's the English name for the yellow sphere? _____

2) What's the English name for the blue and white sphere? _____

3) What's the English name for the smallest sphere? _____

4) What is the Sun made of?_____

5) What is the Earth made of? _____

6) What is the Moon made of?_____

Appendix 4

Read the text and underline the words you don't understand.

The Moon goes around the Earth in an elliptic path. The Earth and the Moon together orbit around the Sun in an elliptic path too. Gravity is the force that keeps the Earth and the Moon in their path around the Sun. Gravity is the force of attraction among all the objects existing around us.

When we throw a ball up in the air it's the Earth's gravity that makes it come back down. Gravity pulls all the bodies toward its centre.

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Without gravity we would fly away from Earth into deep space. Without gravity the air would go away from the Earth. Without gravity the Moon would go away from the Earth.

The force of gravity between two objects is stronger if they are near each other. The force of gravity is stronger if the masses of the objects are greater. We say that gravity is directly dependant on the mass of the objects and inversely depending on the distance.

Newton's gravitation law says $$F = \frac{m_1 * m_2}{d^2} * G$$

where F is the force of attraction between two bodies having mass m_1 and m_2 respectively,

d is the distance between the two bodies,

G is the universal gravitational force constant.

The second part of the formula $\frac{m_2}{d^2} * G$ depends only on the planet we are on. It is called gravitational acceleration on the surface of the planet (or satellite or star) and has a fixed value. We can then write that the weight (F) of a body is

$$F = m_1 * acceleration\ of\ the\ planet$$

where m_1 is the mass of the body. The weight depends directly on the mass and on the gravitational acceleration of the planet.

Example:

Thomas is a boy and his weight on the Earth is 50 kilos. The gravitational acceleration on the Earth is 9,8 m/s^2. We want to know the weight of Thomas on the Moon. The gravitational acceleration on the Moon is 1,6 m/s^2.

We write a proportion 50 : 9,8 = X : 1,6

The weight of Thomas on the Moon is then 50 *1,6 / 9,8 = 8,16 kilos

Appendix 5

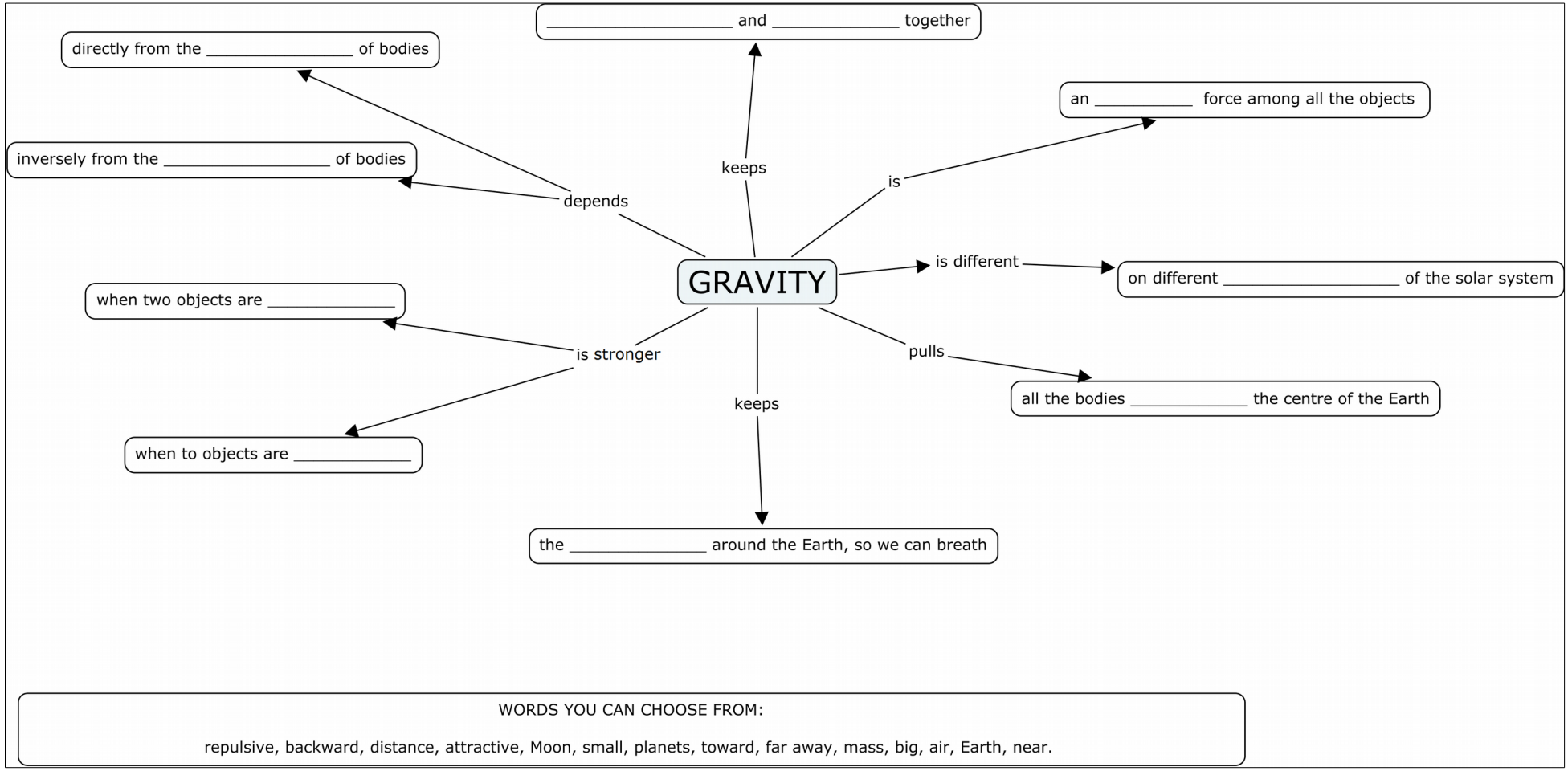
Use this table to record the weights of Thomas and his cat Jerry on the surface of different places in the solar system. Then answer the question below.

Name of the star/planet/ satellite	Sun	Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune
Gravitational acceleration	274,8 m/s^2	3,7 m/s^2	8,9 m/s^2	9,8 m/s^2	1,6 m/s^2	3,7 m/s^2	24,8 m/s^2	10,5 m/s^2	8,7 m/s^2	11,2 m/s^2
Weight of Thomas				50 kg						
Weight of Jerry the cat				2,5 kg						

Thomas can lift up to 40 kilos and loves his cat. But somewhere in the solar system he is not able to hold Jerry in his arms. Where?

_____

Appendix 6


_____ and _____ together
directly from the _____ of bodies
an _____ force among all the objects
inversely from the _____ of bodies
keeps
depends
is
GRAVITY
is different
on different _____ of the solar system
when two objects are _____
is stronger
pulls
all the bodies _____ the centre of the Earth
keeps
when to objects are _____
the _____ around the Earth, so we can breath
WORDS YOU CAN CHOOSE FROM:
repulsive, backward, distance, attractive, Moon, small, planets, toward, far away, mass, big, air, Earth, near.

Appendix 7 (simplified text)

Read the text and underline the words you don't understand.

The Moon goes around the Earth. The Earth and the Moon together orbit around the Sun. Gravity is the force that keeps the Earth and the Moon in their orbit around the Sun. Gravity is the force of attraction among all the objects in the world.

The force of
gravity between two objects is stronger if they are near each other. The force of gravity is stronger if the masses of the objects are greater.

Newton's gravitation law says $F = \frac{m_1 * m_2}{d^2} * G$

where F is the force of attraction between to bodies
m_1 and m_2 are the masses of the two bodies
d is the distance between the two bodies
G is the universal gravitational force constant.

The part of the formula $\frac{m_2}{d^2} * G$ depends only on the body we are on.

It is called gravitational acceleration of the planet (or satellite or star) and has a fixed value for each celestial body of the solar system.
We can then write that the weight (F) of a body with a mass m_1 on a planet is

$$F = m_1 * \text{acceleration of the planet}$$

The weight depends directly on the mass and on the gravitational acceleration of the planet.

Example:

Thomas is a boy and his weight on the Earth is 50 kilos. The gravitational acceleration on the Earth is 9,8 m/s^2. We want to know the weight of Thomas on the Moon. The gravitational acceleration on the Moon is 1,6 m/s^2.

We write a proportion 50 : 9,8 = X : 1,6

The weight of Thomas on the Moon is then 50 *1,6 / 9,8 = 8,16 kilos

Appendix 8 (simplified table)

Use this table to record the weights of Thomas and his cat Jerry on the surface of different places in the solar system. Then answer the question below.						
Name of the star/ planet/	Sun	Mercury	Earth	Moon	Jupiter	Neptune

satellite						
Gravitational acceleration	274,8 m/s^2	3,7 m/s^2	9,8 m/s^2	1,6 m/s^2	24,8 m/s^2	11,2 m/s^2
Weight of Thomas			50 kg			
Weight of Jerry the cat			2,5 kg			
Thomas can lift up to 40 kilos and loves his cat. But somewhere in the solar system he is not able to hold Jerry in his arms. Where? _____						

Appendix 9

Use this grid to create a word search with the words of the mind map of the first lesson

Appendix 10

	Excellent	Good	Satisfactory	Unsatisfactory
Computing with proportions	Student computes correctly from 90% to 100% of the weights	Student computes correctly from 70% to 89% of the weights	Student computes correctly from 50% to 69% of the weights	Student computes correctly less than 50% of the weights
Comparing results	Student uses English most of the time comparing work in pairs	Student uses some English sentences comparing work in pairs	Student uses some English words comparing work in pairs	Student never uses English comparing work in pairs

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